**Technical Report for Focus Group Recommendations**

**Herculaneum, MO**

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1. Background

A. Site Background (From SOW for - **Contract No. 68-S7-01-41, Task Order 0108)**

The Herculaneum Lead Smelter, located approximately 25 miles south of the St. Louis metropolitan area in Herculaneum, Missouri, is an active lead smelter that began its operations in 1892. Many studies have been conducted to help characterize the impact the smelter has had, or is currently having, on the surrounding community of Herculaneum, Missouri. Both past and present studies have indicated lead levels that exceed the current cleanup level for soil. This soil cleanup level is sometimes exceeded by more than 300 times. Current studies have shown that the road dust along haul routes contains extremely high concentrations of lead, which are of greatest concentration along the routes bringing lead ore to the smelter. These levels decrease in concentration as one moves away from the smelter along the routes taken by the empty trucks. In some instances, the lead concentration in road dust exceeded 190,000 milligrams per kilogram (mg/kg).

In addition to high levels of lead found in soil and road dust, several children have exhibited elevated blood lead levels (EBL). To help reduce the children's risk of exposure to lead, the soil from several yards were excavated and replaced with soil with lead levels below 240 mg/kg (mg/kg = ppm). The first groups of yards excavated were those surrounding homes with children exhibiting EBL. Eventually, all homes with soil lead concentrations above 400 mg/kg will be excavated.

For the surrounding community of Herculaneum, Missouri, cleanup or action levels were established for air, soil, and interior floor dust wipe and interior windowsill dust wipe samples. No levels were established for road dust or indoor carpet dust samples. The soil cleanup level of 400 mg/kg was established using the EPA Region 9 Preliminary Remediation Goals. The air action level of 1.5 micrograms per cubic meter (µg/m) was established using the National Ambient Air Quality Standards. The interior floor dust wipe cleanup level of 40 micrograms per square foot (µg/ft2) and interior windowsill dust wipe cleanup level of 250 µg/ft2 were established using standards developed by the Department of Housing and Urban Development (HUD). The HUD standards are based on protocols established for lead-based paint cleanup. Because these levels do not account for lead arising from sources other than lead-based paint, such as lead smelter activities, Tetra Tech START was tasked to coordinate the establishment of a proposed set of site-specific, scientifically-based interior lead dust cleanup levels. These proposed levels are to be developed by lead dust experts, with input from a Focus Group which would consist of members of the community, several federal and state agencies, and the potential responsible party.

B. Focus Group Objectives

EPA will engage members of the community; lead dust experts; and representatives from the Missouri Department of Natural Resources (MDNR), Missouri Department of Health and Senior Services, (MDHSS), Agency for Toxic Substances and Disease Registry (ATSDR), Jefferson

County Health Department, and the Doe Run Company to participate in the observation of the development of a site-specific, health-based, cleanup standard and action strategy for lead dust contamination present in home interiors:

i. Identify, provide and review critical and relevant studies on interior lead dust.
ii. Provide and review site-specific environmental data.
iii. Recommend site-specific health-based indoor dust cleanup level goals.
iv. Recommend site-specific sampling protocols.

2. Recommended Site-Specific Interior Cleanup Level

- Background

In developing a recommendation for site-specific, scientifically-based dust lead clean-up levels for Herculaneum, one of the factors to consider is the considerable scientific evidence that the current US EPA standard of 40 $\mu g/ft^2$ for floors is too high to ensure that less than 5% of the children have a blood level greater than 10 µg/dl (Lanphear et al. 1998). Additional evidence is from the Big River Site, a lead mining area of Missouri (Sterling et al. 1999). Another major consideration is that the EPA standard was designed to deal primarily with houses where lead-based paint (LBP) is the primary lead source. In Herculaneum, in addition to the lead-based paint that has been detected in some of the houses, there is also the additional source associated with the lead smelter activities. A portion of the exposure from smelter-related activities has been through the air for over 100 years. Fallout from these emissions has built-up in the soil and other deposition locations over time. Although lead from smelter emissions is apparently on the decline, Herculaneum has an historical environmental burden that has accumulated when the air lead levels and other emissions were considerably higher than at present.

An additional more recent lead source is spillage from ore concentrate that is now being trucked to the smelter on haulage roads that pass through residential areas of Herculaneum. We feel this is a major contribution to indoor dust based on: the lead speciation report by Johnson and Abraham (2002) indicating that the majority of house dust is derived from the soil and road; and the bioavailability report by Casteel et al. (2001) indicating that the ore concentrate was found to be an estimated 71% as bioavailable as the lead in lead acetate. In addition, the available dust lead data from the Herculaneum site exhibits a strong correlation of house dust lead with distance from smelter. House dust lead loading decreased as distance from smelter increased. For example, levels at one-half mile were about one-half of those at one-quarter mile; levels at one mile were about one-eighth of those at one-quarter mile. However, exterior dust lead levels were not correlated with distance from smelter, suggesting that they may be related to spillage from lead ore concentrate trucks that pass through the community.

The available blood lead data and corresponding environmental lead data for Herculaneum do not allow a determination with any certainty of the exact dust lead cleanup level to recommend using only site-specific data. An analysis of the limited amount of blood lead data available did

reveal a very strong correlation with distance from the smelter as mentioned in the previous paragraph with house dust lead loading. This suggests house dust is one of the major contributors of lead exposure to children. Floor clean-up levels of less than 24 µg/ft2 determined from the Big River lead mining site (Sterling et al., 1999) in St. Francois, MO, were found to be associated with no more than 5% of the blood lead values above 10 µg/dl. Over 80% of the sites evaluated from the Big River study had soil levels greater than 400 ppm, the soil clean up level presently being used in Herculaneum, and the lead dust is primarily from ore concentrate, also similar to that used in Herculaneum.

Suggested Workplan

Based on the above and similar findings by Lanphear et al. (1998) that the current EPA standard for floors of 40 µg/ $ft^2$ is not sufficiently protective, a floor lead clean-up goal that is lower than the current EPA standard for floors is recommended. From a scientific basis, and supported by Sterling et al. (1999), a goal of 20 µg/ft2 is recommended. Using the most recent data available, 12 of the 17 houses in Herculaneum have floor dust lead levels of less than 20 µg/$ft^2$ measured during the last sampling period of each house. With additional interior house dust lead removal, lead-based paint stabilization and repeated exterior lead dust street cleaning, the latter on an expanded area basis, the goal of 20 µg/ft2 appears to be attainable. There is no corresponding literature available for windowsill clean-up goals; however similar reasoning would suggest a goal of 125 µg/ft2. Currently 50% of the houses have windowsill lead levels consistently less than this value at the time of the last sampling period. There is a statistically significant trend for house dust levels to decrease with time, which may be related to long-term impact of soil replacement, street cleaning and cleaning of additional homes.

3. Recommended Site-Specific Interior Cleanup Protocols -

Background

For 15 of the 17 houses for which data has been presented, the special lead dust removal occurred prior to May 2002, the date that major emission control efforts at the Herculaneum smelter were in place. A communication provided to the Focus Group by Doe Run indicated that this premature cleaning might be responsible for some houses not meeting the HUD cleanup goal. We suggest that consideration be given to cleaning these houses again.

For 4 of these 17 houses, at least one dust wipe sample during the last recontamination sampling for that house had a lead level that exceeded either the EPA floor or window sill standard. Three of the 17 houses in the last sampling period exceeded the EPA floor standard. Four houses exceeded the windowsill standard, which included the same 3 houses above. Of the 3 exceeding the floor dust sample, 2 had interior lead-based paint present. These findings suggest that the soil removal and replacement at the house and/or the household cleaning program were generally sufficient to bring dust lead levels below the present EPA health-based standard and to the proposed clean-up level. If houses that were cleaned before completion of the major smelter emission control improvements were put into place are recleaned, as recommended in this report,

levels are likely to further decrease. The excedences of current EPA dust lead limits may be due to high levels of lead dust found in street samples, deficiencies in the house cleaning protocol, contamination from neighboring house areas that have not received either soil abatement or house clean up, contamination dust reservoirs in the house (e.g. attic spaces, basements and wall cavities), the presence of LBP, or continued contamination from the smelter operations or some combination of these factors.

The results of the carpet cleaning efforts are similar to those reported in Ewers et al. (1994) and Yiin et al., (2002), where the difficulty in cleaning carpets was demonstrated. These data support the recommendation that consideration be given to replacing some of the carpets. Establishing objective criteria involving actual dust lead measurements of individual carpets would be difficult and expensive. It would involve determining the loading (µg/ft), cleaning the carpet, retesting and determining if the cleanup level was met. If not met, replacement would be warranted. It is likely that the cost of this procedure would be at least as high as the cost of replacement. Review of the literature doesn't provide any explicit information as to when a carpet should be replaced when routine or even extensive cleaning fails to adequately reduce lead loading. In the Ewers, et al. (1994) study naturally soiled carpet was taken from homes and vacuumed at a rate of 1 min/$m^2$ using high efficiency vacuums. After four cleaning cycles of the carpets (total of 4 min/$m^2$) the cumulative average amount of lead removed was 74% of total that was removed after a total of 10 min/$m^2$. Ewers, et al. (1994) found that surface lead loading can actually increase after the first one or two vacuum cycles, however, on average lead loading will usually be reduced after the third cleaning. Lewis, et al. (2002) studied various aspects of lead loading, pile density, and wear on removal of lead-contaminated dust using a dry vacuuming process and typical home vacuum cleaners. Using artificially soiled carpets they found that lower initial lead leading did not affect of lead removal effect on removal from high or low-density carpet. At high loading, however, pile density had a major effect on lead removal with 54% more lead removal from low-density carpets. More importantly, at high levels of loading carpet wear has a significant effect on lead removal, particularly with low-density carpets (or possibly inexpensive carpets). In summary, it appears that many carpets may be able to be cleaned to reduce lead loading below HUD action levels. However it may take a number of thorough cleanings and the carpets may not remain clean if the carpet is heavily contaminated or worn. If carpet wipe dust lead levels do not meet the established goal after thorough cleaning, particularly if the carpet shows visible signs of wear, than it be removed from the house. It is recommended that, where feasible, new carpets not be put back into the housing, since it is easier to clean a solid hard surface more effectively than cleaning carpets. Some floors would have to be treated to fill cracks and other repairs made to make them cleanable and smooth enough for walking directly on them.

The carpets of many of the houses have been sampled using both the HUD wipe method and a HEPA sampling method on side-by-side areas. The HEPA method uses the same equipment as is used in the street and exterior entry dust sample collection. The vacuum method produces a sample that can be tested for both lead concentration (ppm) and lead loading (µg/$ft^2$). Statistical analysis has shown that the concentration and loading are correlated (r-squared = 0.75, $p < 0.0001$). The vacuum method sample has an average loading value about 150 times that of the

wipe method since it is capable of capturing dust from below the carpet surface.

A brief examination of the X-Ray Fluorescence (XRF) paint lead monitoring results from Herculaneum revealed that 8 of the 15 houses for which data were available showed lead-based paint (>= 1.0 mg of lead per square centimeter) on interior and/or exterior surfaces. For the houses where exterior results were not provided, it was not noted whether or not exterior painted surfaces were present or tested. It is important that housing units be examined for lead-based paint using the protocol specified in the HUD Guidelines when elevated blood lead children are present or where dust lead level goals cannot be met. If the Jefferson County Health Department needs additional resources to conduct such an expanded testing program, it would be helpful if such resources were made available. Emergency paint lead stabilization and abatement funds/skills should be made available such as for EBL events or other homes where young children move in and lead dust goal levels have not been achieved.

Suggested Workplan

A. Basic Considerations

Ideally, cleaning should be performed in a manner so that residents can re-occupy the home the same day. In order for this to be accomplished, the analytical method used to determine if the cleanup goals had been met must be capable of providing results soon after dust wipes are collected, preferably within an hour. If floors have to be sealed, an overnight relocation will be required because the sealing material will take some time to dry. Residents should, if possible, not have more than one-overnight relocation. Doe Run and/or the cleanup contractor should be responsible for quickly replacing or fixing any items damaged by the cleanup with items of equal or greater replacement value. Prior to the initiation of any cleanup activity in a home the resident and the contracted cleanup team should meet to review a standard cleanup contract outlining the process and specific responsibilities of those involved. Consideration should be given to documenting pre-cleaning conditions through use of a video camera with the recording to be destroyed after satisfactory completion of the cleaning. Any special circumstances or issues associated with the residence and the scheduled cleanup will be noted and incorporated into the contract at that time. At a minimum, cleanup shall be performed following the protocol set forth in HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing. Sampling of lead levels shall be performed in all locations specified in the protocol and any other areas determined to be needed such as because of use as a living area or otherwise affecting the living area. If a Herculaneum or house-specific interior cleanup plan specifies more stringent or more extensive cleanup measures, the plan shall take precedence over the HUD Guidelines. A brochure should be developed, probably using an existing brochure as a starting point, to assist the residents in performing some special lead dust clean-up operations on their own. If overnight relocation is required, adequate provisions for relocation and lodging should be made.

B. Cleaning Method

The lead dust clean-up protocol in the HUD Guidelines for the Evaluation and Control of Lead

Based Paint Hazards in Housing (HUD, 1995) should be specifically followed. These guidelines specify important details such as the amount of time needed for the cleaning process for both carpets (HUD Chapter 11) and hard surface areas. Cleanup shall also include furniture and play area items. Cleaning should be performed in a manner so that residents can re-occupy the home the same day whenever feasible. Performing a post clean-up test method that provides immediate results is needed to facilitate this happening. Re-cleaning should occur in any room, and similar surfaces in rooms not tested, that exceed the set value for the sampling method used.

4. Recommended Site-Specific Interior Sampling Protocol

A. Pre-Cleaning Monitoring

Sampling for lead in house dust should be performed ***prior*** to all cleaning activities, and should occur no more than seven days prior to cleaning. A modified HUD evaluation protocol should be used which involves the collection of a minimum of seven to nine dust wipe samples taken from a minimum of 4 floors and 3 windows (Galke et al., 1999). Two children's bedrooms should be sampled if there is more than one child under the age of 6 living in the home. Recommended sampling locations include: floor sampling from the interior entry, doorways to the kitchen, youngest child's playroom area (may be living room) and bedroom, and second child's bedroom if present: interior window sills from the child's bedrooms, playroom and kitchen. Additional floor samples must be collected in the attic and/or basement if used as a living or play area, or otherwise accessed frequently.

B. Post Cleaning Evaluation Of Interior Cleaning Performance

Portable x-ray fluorescence analyzers (NITON, Inc.) are capable of providing rapid analysis of dust wipes as soon as they are collected as has been documented by research of the authors of this report. Readings should be taken for 60 nominal seconds as specified by the manufacturer. If results from floor dust wipe samples are at or above a value determined through site-specific developed calibration curves, the level shall assume to be at or above the clean-up level established and cleaning shall be repeated. Evaluation of cleaning should be performed. All testing for lead in house dust following cleaning should occur no sooner than one-hour after, and no later than 24 hours after cleaning is complete. Subsequent testing of cleaning should consist of samples alternating from one side to the other of the doorway or window for the first two times. If additional re-cleaning and testing is needed, samples should be taken from alternate windowsill and floor areas.

If carpet lead dust wipe results are greater than set value, and the carpet is not considered cleanable (i.e. would be damaged, etc.), then resident is eligible for carpet replacement, which includes removal of padding and cleaning of subfloor. Preferable to carpet replacement, as mentioned earlier, is ensuring that the uncarpeted floor is cleanable and otherwise appropriate for residential use. Otherwise, decisions will be based on post cleaning results. Collection of a wipe from an immediately adjacent area from which a carpet vacuum sample had just been collected

may provide useful additional information to be used in the decision-making concerning possible carpet replacement. If a carpet test following any cleaning, and particularly re-cleaning, exceeds set point, then resident should be considered for carpet replacement or making the floor cleanable.

An occupant satisfaction survey will be developed and used following the completion of all cleaning activities. The form should be designed to determine the resident satisfaction of the overall process and allow feedback for modification of the process and procedures as needed.

C. Follow-up Monitoring

All homes where cleaning is performed are to be checked on a quarterly basis if resources are available. Sampling will be performed in a similar manner and locations as the pre-cleaning monitoring. If one room exceeds the standard, a cleaning of that room must be offered. If two or more rooms exceed the standard, a cleaning of the entire house must be offered. If levels are found to be greater than or equal to 20 $\mu g/ft^2$ for two follow-up tests, a more thorough inspection for lead re-contamination sources will be performed. This inspection should include lead-based paint; evidence of dust lead seepage from attics, air ducts and walls and outdoor sources. The results of this inspection will form the basis for the development of a site-specific intervention plan, and corrective measures taken. A complete inspection and determination of potential source such as above should also be performed for all elevated blood lead events. In addition, interim control measures shall be performed/provided, such as walk off doormats for entryways to reduce the tracking of dust, sod for bare yard areas, and so on.

Homes cleaned on one or more occasions prior to the adoption of the Revised Interior Cleanup Plan shall be considered part of this plan, and are eligible for home quarterly follow-up based on the same guidelines. These houses should be considered for additional cleaning if dust lead goals have not been achieved. Issues associated with difficulty with obtaining initial and follow-up access into homes for cleaning and monitoring need to be addressed.

5. Other Action Items

A. Additional Sampling (other than interior)

Soil Replacement and Monitoring

Background

A significant amount of interior dust comes from exterior sources. This connection has already been recognized in the Herculaneum cleanup project, insofar as residents are not eligible for interior cleaning unless they first have their yard soil tested and replaced where necessary. Yard remediation should be done in the most effective manner possible with the least amount of inconvenience to residents. Soil contamination poses two risks: residents can be exposed to lead directly from soil dust while they are outside their own and neighbors yards, and soil dust

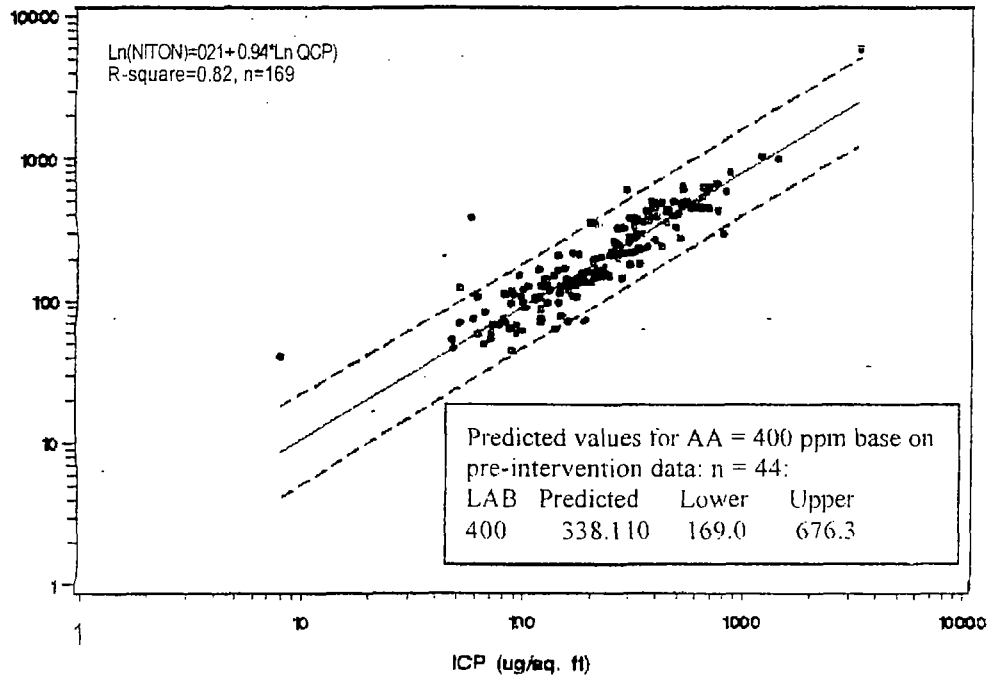
(containing lead) can contribute to household dust and hence to interior lead exposure. It is important that all residents eligible for soil testing and replacement participate in the program to help reduce potential for recontamination of neighboring areas.

The current US EPA standard of 400 ppm for bare soil in residential areas appears to be appropriate for Herculaneum. Post intervention soil lead measurements in Herculaneum to check for recontamination show an overall mean of 87 ppm. An ATSDR Health Consultation noted one home in Herculaneum that had its soil replaced in 1999 with soil containing 14 ppm lead (ATSDR, 2002), had levels above 400 ppm in testing performed in 2001. This shows that recontamination has occurred. Since replacement soil containing only 14 ppm was apparently available in 1999, we recommend that replacement soils have a lead level less than the current guideline of 100 ppm, provided that the soil also meets agronomic requirements.

Using the soil preparation methods practiced at the time of this data collection the field portable XRF (X-ray fluorescence analyzer) device gave lead measurements that tended to underestimate the soil lead concentrations. For example as demonstrated in Figure 1, using the pre-replacement available data the XRF must give a reading of 170 ppm or less for there to be a 95% certainty that the soil lead concentration (as measured by atomic absorption (AA) analysis) is in fact less than 400 ppm (Clark and Sterling, 2002). It may be useful to investigate other methods of preparing soil samples, such as by a simple sieving process that can be performed in the field, so that the XRF results more closely match those obtained with atomic absorption. Another field portable lead-testing method that could be investigated for possible use is Anodic Stripping Voltammetry (ASV).

Figure 1

**Relationship Between Soil Lead Levels Measured by Field Portable XRF and by ICP Method (Pre-intervention)**




Suggested Workplan

It is important to increase the participation of residents in the soil sampling and replacement program. Use of sod rather than grass seed could increase the percentage of residents who participate in the program. The yard remediation procedure should not take longer than one week; from the time removal of old soil begins until the time the sod has been completely installed. In addition this work should be completed during the workweek (i.e. bare soil should not be left exposed over a weekend). There should be a minimum of six inches of topsoil; the soil should have a low lead content (less than 100 ppm and as close as possible to the national average of 40 ppm). However, the replaced soil/sod must meet the agronomic needs for which it is intended.

Based on a review of the results of the post-intervention soil monitoring protocol, there does not appear to be any evidence that the replaced soil is becoming contaminated during the first year since soil replacement. Since soil recontamination would be initiated with the top layers of soil becoming contaminated from fallout or ground level transport of lead containing particles, the top one-inch soil lead sample would not readily reflect such contamination. Surface scraping samples are a more sensitive indicator of contamination of the replaced soil by lead dust and were instituted by the EPA in Herculaneum during 2003. We did not have the opportunity to review the additional surface soil sampling data and so cannot comment on those results. If a written protocol is not yet prepared, a protocol for a soil-scraping sample is available in the Protocol from the Three City Urban Soil-Lead Abatement Demonstration Project (EPA 1993).

We suggest that quarterly monitoring include a collection of soil surface-scraping samples. B.

B. Long-Term Monitoring

Long-term monitoring is important to evaluate the success of any intervention implementation programs, to detect needed modifications/changes, and to help determine the need for continuing corrective actions. This monitoring should be performed at homes that participate in the cleaning program and/or soil replacement program, at selected sentinel homes and at selected street sample locations. Long-term sampling method types should include those for settled dust within homes (wipes and carpet vacuum samples), exterior and interior dust fall, soil scraping and cores, and street and exterior entry dust vacuums. Methods for all sample collections have been previously described here and/or elsewhere.

Dustfall data would provide another way to monitor the impact of emission control measures associated with the smelter and its operations and the neighborhood dust lead removal efforts. Protocols for interior dust fall are available from the Trail, B.C. Task Force and from the US EPA Urban Soil Lead Demonstration Project (EPA/600/AP-93/0010, August 1993). Exterior dust fall measure should be obtained at areas that can be kept secured, such as air monitoring stations and/or by the EPA trailer or school, and that are representative based on distance and typography. We understand that EPA/Tetra Tech are considering and performing a dustfall trial. They should reference and/or discuss the dustfall method that they are developing.

We also recommend two exterior dust vacuum samples being added to the house testing protocol: an exterior entry sample and a street sample. These samples can be collected by the procedure that is currently being used in Herculaneum to collect street dust samples. At the time of the completion of this report, it is our understanding that this additional monitoring had already been added to the Herculaneum sampling protocol.

Table 1: Recommended Long-term Sample Locations, Types and Frequency

| | Locations | | | | |
|---|---|---|---|---|---|
| Sample Type | Sentinel | Interior Cleaning | Soil Replacement | Streets | Other |
| Dust Wipe | Quarterly | Quarterly | | | |
| Dust Vacuum - Carpet | Quarterly | Quarterly | | | |
| Dust Vacuum - exterior entry | Quarterly | Quarterly | | Quarterly | |
| Dust Vacuum - street | Quarterly | Quarterly | | Quarterly | |
| Dust Fall - Interior | Quarterly | Quarterly | | | |

| | | | |
|---|---|---|---|
| Dust Fall - Exterior | | | Quarterly - secure location |
| Soil Sera in - Soil Core | Bi-annually | Bi-annually | |

C. Trust Fund

It is more cost effective to perform attic and wall cleanup at the same time as home renovations are underway, or as additional lead-based paint hazard reduction measures are performed. Timing is the issue, and if these activities were going to occur after much of the other lead exposure reduction measures were to be implemented, then it would make sense to establish some procedure to make sure funds were still available to support these efforts. The time when ceilings and walls are removed/replaced/repaired also presents good opportunity for considering whether additional insulation is needed for the home. The need for such insulation is independent from the lead issue, but it would be more economical to perform when access to wall space and attics is available. Other activities that might be included in such a fund are:

- Home renovations that will disturb areas not previously sampled and may be contaminated, such as air ducts, wall partitions, attics, ceilings, and basements;
- Further sampling and intervention needed when goals cannot be met - such as house dust levels after two follow-ups, recontamination of yards, and so on;
- Additional investigations and corrective action resulting from EBL events;
- Monitoring and cleaning needed when families are moving into previously untested homes with children;
- Long term relocation during home remediation; and,
- Permanent relocation, such as home buy out. A mechanism/plan is needed to eventually bring these into lead safe housing condition for re-occupancy or to be replaced by new housing.

D. Health Communication -

Background

Implementation of an effective workplan requires that Herculaneum residents believe that the plan is effective, they must trust the individuals that will be implementing the plan, and they must participate in the plan. Such trust cannot be expected unless the residents are provided sufficient information about, and input into, the process. This can be best achieved through some or all of the following educational/communication methods.

Community-specific literature is needed. This information is also needed for painters, remodelers, hardware stores in addition to homeowners and renters It would also be useful to develop or locate existing education modules that can be used in the public schools at various grades. If there is a vocational school in the area that has home improvement courses, they might

be able to disseminate the educational materials.

Educational materials should be prepared for such activities as renovations, attic access and wall interior remediation. The results of the exploration of Doe Run test and other homes could provide site-specific intervention techniques and photos of situations that occur in Herculaneum.

It is necessary to provide for the disclosure to present and future home occupants and owners on existing and potential lead hazards. This is important and is required by law when there is information on lead hazards. This information disclosure also should include real estate agents, financial institutions, etc.

The broad representation of the Task Force can help develop appropriate delivery modes for educational materials. It would be useful to invite others to observe some of the Task Force and other related meeting and/or to hold the Task Force meetings in conjunction with PTO's, and so on. There may be a teacher(s) in the school system that is interested in using some aspect of the Task Force activities as a class project or for extra credit. The State of California produced a 'lead calendar' a couple of years ago which used drawings by school kids to illustrate a number of points- the effects of lead on children, ways lead exposure occurred, ways to reduce lead exposure, etc. There are a number of such examples. Maybe some can be developed here.

A focus group could also explore reasons why soil replacement and special home treatment for lead removal programs do not seem to be acceptable to a number of community members.

E. Task Force

All Herculaneum work plan activities shall have an ongoing evaluation such as by a Community Oversight Board.

Such a board could consist of members from the following groups:

- The Herculaneum Community Advisory Group
- US EPA
- Other agencies (DNR, ATSDR, etc.)
- Doe Run Corporation
- Contractors
- Outside experts

The Board could review comments or complaints made by residents. The Board could report grievances and recommend courses of action to remedy such grievances to the responsible parties.

To aid the Board, residents should be given evaluation forms to complete upon conclusion of any workplan activities. These evaluation forms should be simple to complete and submit to the Board.

On an annual basis all workplan activities shall be evaluated in order to:

- *Assess the effectiveness of the plan.* Measures of effectiveness include community participation rates, level of community satisfaction with the decontamination program, efficiency of the protocol, and attainment of lead contamination goals.
- *Recommend and implement changes to the plan, if* deemed necessary to increase the effectiveness of the cleanup process. The cleanup plan shall maintain its basic structure and function in any revisions, but specifics such as cleanup procedure, lead clearance goal levels, or grievance reporting mechanisms may be modified to better achieve Herculaneum health goals.

6. Other Action Recommendations

A. Impact of Street Dust Lead on the Environment -

**Background**

Since lead in dust is mobile, it can move from site to site within a community. Such movement varies with time and varies between communities depending on the sources and activities occurring. Street dust lead has been found to contribute to the loading at the exterior entry to housing, which then impacts interior dust lead levels. In Herculaneum, spillage of lead concentrate from haulage activities can contribute to high street dust lead levels in some areas. In areas where paint lead is the major source, soil and exterior entry dust lead has been contributing to soil lead. Lead levels in various environmental compartments (street dust, other exterior dust, soil and interior dust) are interrelated. Since the sources of the lead can vary, the pathways among the environmental lead variables can also vary. In the HUD Evaluation (Clark et al., 2003), which involved houses in many areas of the country, it was found that in general lead from housing (exterior dust and soil) affected lead levels on streets. (In Herculaneum the reverse may be true, especially along the haulage routes.) In addition, the HUD evaluation results showed that lead at the exterior entry of the house moved toward the interior portions of the house. A study of samples in Herculaneum from streets, soil and houses concluded that 30% of household dust comes from exterior soil and 50% is from road dust (Johnson and Abraham, 2002). Similar conclusions about the contribution of soil to interior dust were reached in several other studies conducted outside of Herculaneum: One study estimated that 30% of household dust came from soil (Calabrese and Stanek, 1992). Another study found that 37% of household dust came from soil (Sterling et al, 1998). Yet another study estimated that 50% of household dust originated in soil (Forbes et al, 1986). Monitoring all three locations can help in subsequent corrective actions for homes where re-contamination continues to be a problem.

Dust lead levels on Herculaneum streets are the highest reported (Clark and Sterling 2002), probably due in part to the transport of lead concentrate through the streets in Herculaneum. A review of the street cleaning data presented at the September 2002 Focus Group Meeting

revealed a considerable overlap in lead dust concentration and loading between primary and secondary lead concentrate haul routes Overall, concentrations and loadings appear to be lower on the secondary haul routes than along primary haul routes. There is, however, a considerable overlap in the ranges of values with maximum values at sampling locations varying from 5900 to 190,000 ppm (mg/Kg) compared to 37,000 to 94,000 for the primary routes. Values at secondary route sampling stations ranged from 1,009 to 34,900 ppm (median 3,700) and 0.72 to 7.22-mg/$ft^2$ (median 1.34), compared to 8,100 to 40,000 ppm (median 16,000) and 0.77 to 8.72 mg/$ft^2$ (median 2.38) for the primary route stations. The overlap raises the question of whether other streets in Herculaneum have similarly high levels. Concentrations of lead in street dust in Herculaneum (median of 16,000 ppm and 3,700 ppm on primary and secondary routes, respectively) are much higher than those in Trail where levels were 1123 ppm before the new smelter was built and 888 ppm afterwards. The street dust lead loadings in Trail decreased from 20 mg/$ft^2$ before the smelter was installed to 11 mg/ $ft^2$ afterwards. The Trail levels are much higher than those in Herculaneum, median of 2.38 mg/$ft^2$ and 1.34 mg/ $ft^2$ on primary and secondary routes, respectively.

Suggested Workplan

To evaluate the relationship between exterior entry dust lead and lead levels in street and house dust, we recommend that the sampling method presently used in Herculaneum to obtain street samples should be employed at all homes being monitored to sample their exterior entry areas and adjacent street dust. Additionally, street dust monitoring locations should be established near the smelter - especially near entries and exits to property (haulage roads, employee and supplier entry roads etc) to help monitor the effectiveness of smelter emissions and haulage spillage reduction activities. Sampling sites on streets that are not primary or secondary haulage routes should also be selected.

The frequency of the monitoring for street dust should be quarter, but with the additional sampling specified here and in later sections following. Depending on the results of this expanded street dust sampling, the need for cleaning these other areas can be assessed. If levels are similar to primary or secondary haulage routes, cleaning should be considered on a similar frequency.

B. Sentinel housing

Houses of representative ages and locations in regards to distance from the smelter and ore haulage routes should be included. It is possible that this has already occurred. It should be possible to find data on the age of the Herculaneum housing stock to make sure that the houses sampled are representative of the housing in the community.

C. Test housing/Attics/Walls

Attics are usually very dusty. Since attics are usually designed to have ventilation that is adequate to prevent moisture build-up, there are openings to the outside air. These openings have allowed

air contaminants to enter the house over the years and the particles to settle. Sealing the attics would have to be performed in a manner that would preserve the ventilation characteristics while at the same time trying to minimize entry into the living space. Provided the ceilings are intact, most of the attic contaminating that enters the living space probably comes through the access to the attic (trap doors, pull-down stairs, regular stairs etc). It would first have to be determined the type of access to the attics and the use of the attics. This can range from: very limited through a trap door of some type to fully finished attics. It is likely that many of the homes have the former type. If that were the case it probably would be more effective to prepare a better trap door, taking care to prevent house contamination during the process. If the ceilings below the attics are in poor condition and contain lead-based paint, then replacement may be warranted since patching plaster is expensive. To obtain a smooth finish, moreover, it is usually more economical to replace the plaster ceiling with drywall. If that were done, it would make sense to clean the attic at the same time since the dust would be disturbed in the process. The basic cleanup effort needed for this task, would amount to a major portion of the attic clean up.

In order to explore the level of lead contamination in attics and within wall, and the impact of attic fan use, it would be useful to explore contamination levels and useful remediation techniques in some vacant houses that have been purchased by Herculaneum. Various approaches could be taken to clean attics, ductwork and walls; the extent of lead contamination in these areas could be determined and the extent to which these locations of lead dust contaminate the living space could be explored. As long as attics are not part of the living space, site-specific clean-up levels would not need to be achieved, only a significant reduction in available lead dust and a reduction of its impact on living areas.

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